Modeling tuition fees in presence of social heterogeneity

David Flacher, Hugo Harari-Kermadec

▶ To cite this version:

Modeling tuition fees in presence of social heterogeneity

David Flacher[*] and Hugo Harari-Kermadec[†]

3rd May 2010

Abstract

Tuition fees have been spreading through developed countries in the last decade. Beyond the obvious interest of funding universities, it is advocated that they could serve as a tool to select students. According to some recent models, in presence of asymmetric and imperfect information on the candidates' capacities, tuition should be the only selection device, at the expense of tests.

Following Bourdieu's seminal work on higher education, we consider that powerful sociologic mechanisms induce social reproduction. These effects must be taken into account to understand the behaviour of potential students. In particular, candidates from lower social groups may underestimate their capacities. Therefore, we introduce heterogeneity in potential students' private evaluation of their own capacities. As a result, we obtain that tuition fees do not lead to social optimum, because talented member discard themselves. This effect gets only stronger as entrance tests are abandoned. Nevertheless, we do not recommend strong selecting tests, since the same sociologic mechanisms negatively biased the results of applicants from lower social groups.

---

[*]Université Paris 13, CEPN - CNRS
[†]ENS Cachan and SAMM

Introduction

In a recent article, [6] support the idea that tuition fees can efficiently select students applying to the university. Following this normative conclusions would mean to deeply transform the economic, social, cultural and institutional basis of the current educational system which will have a series of consequences that have to be further identified and analysed. It is thus primordial to check if the assumptions and the results of this research are robust before political implementation. In particular, an important condition is that students observe a private signal on their ability, noisy but unbiased.

In this article we contribute to the debate and argue that heterogeneity of the population must be taken into account when modelling potential students' private signal. Then, relying on theoretical and empirical literature, we discuss more widely the issues of tuitions fees.

The present article is organised as follows: Section 1 discusses the determinants of private signal and justifies the introduction of heterogeneity. Section 2 shows that their results are not robust with regards to this change. Finally, Section 3 widens this fundamental discussion about tuition fees and identifies perspectives for further research.

1   Information and behaviour

1.1   Imperfect and asymmetric information

A central assumption when considering potential students' behaviour is the imperfect and asymmetric perception available about individuals' "talent".

In [6]'s model, each individual has a "noisy" information about her ability. For its part, the university evaluates the applicant ability through examinations and qualitative assessments. As a result, the university also owns a noisy information about the applicants. Therefore, an asymmetric information between applicant and university is modelled. Student's own signal is by nature private, the asymmetry is then "one-sided" if university's information is public and "bilateral" otherwise.

These types of asymmetries are quite realistic and can explain opportunistic behaviours of university applicants. In this model, these behaviours can be efficiently contradicted by implementing jointly tuition fees and examinations. Tuition fees appear to be particularly important in the selection process since the applicant owns an accurate information about her talent (as self-selection improves), since the university has difficulties to assess student's ability (examinations and tuition fees become less substitutable) and since there is only "one-sided" information asymmetry (university's information is common knowledge).

However, this modelling does not take into account the fact that students' behaviours also depend on their social environment. The importance of this factor has been highlighted in the literature: individuals having the same basic talent have different ability to fit with the social codes of examinations and perception of their own ability appears socially biased. Students coming from the socially or culturally privileged classes tend to estimate more precisely (or to overestimate) their talent while students coming from disadvantaged families underestimate theirs[1].

According to the seminal work of [1], "Adolescents will behave [...] in order to achieve what he perceives as a fact: when one belongs to a disadvantaged background, we can not get into university. [...] The skill required in order to 'choose' the best objective strategies (e.g. selecting a financial investment, a school or a career) is very unequally distributed. It varies almost exactly like the power of which the success of these strategies depends on. [...] Thus, even at a high level of curriculum and despite the effects of over-selection, we find that students are particularly

---

[1]The bias regarding the ability to efficiently take an examination in relation to the social or cultural environment will not be addressed in the model presented in the Section 2. This article will be limited to the bias regarding individual's perception of her talent. However, these two effects reinforce each other.

modest in their academic ambitions (as well as in the assessment of their results) and particularly limited in their career projects because they belong to groups whose educational opportunities are the lowest. " (p. 6, 8 and 9).

These "bad academic investment" could particularly be explained by asymmetric information about educational curriculum courses of the different classes of agents[2], by the lack of alternative opportunities in case of failure for individuals not enjoying enough social capital, or by their lack of familiarity with the positions that could be reached through education. The investment into education also reflects a desire from privileged classes to maximise "symbolic" returns, beyond the maximisation of economic ones [3].

Several recent empirical studies confirm the strong correlation between the social characteristics of an individual and her academic perspectives. This is consistent with the hypothesis of socially biased private signal contingent the socially determined ability to "succeed" in studies: [3], show on Canadian data that family characteristics (level of parental education, family type, ethnicity, place of residence) have significant effects on university registration. There is a rich literature on the above mentioned issues and consistent work demonstrating that "Children who grow up in a poor or low income family tend to have lower educational and labour market attainments than children from more affluent families" (see [7], p.1870). In the 1970s, the results of a seminal research have shown that until "one third of the measured role of education in attainments reflects the influence of family background [...]" (p.1841). More recent studies using more accurate in-depth empirical techniques estimate a much higher link [4].

For all these reasons, the assumption by [6], according to which the quality of individuals' information about their own talents would be homogeneous among the population, appears very questionable.

1.2 Proposal for a new assumption

The preceding analysis shows that individual's information about her own talent can not be considered independently from the economic, social and cultural background in which she evolves. On the contrary, a bias in favour of socially or culturally privileged classes should be introduced. This bias may be (at least partially) modelled. Keeping the hypothesis that talents are randomly distributed among the population, we introduce a bias in the perception individuals have of their talent. Instead of modelling this perception by a common and zero mean random variable, we distinguish two groups within the population:

- a group of individuals belonging to "privileged" classes. In this group, each individual perceives a noisy signal of her talent with a positive or zero bias. For simplicity reason, we choose the absence of perception bias for individuals in this class.

- a group of individuals belonging to "disadvantaged" classes. In this group, each individual perceives a noisy signal of her talent with a negative bias, indicating indirectly a mistaken belief in the expected returns from educational investment, a possible greater risk aversion or debt burden aversion[5];

---

[2]According to [1], p.13, "This gap can also lead to inappropriate strategies, because they are fulfilled out of time: employees whose careers have been limited since they did not pass the *baccalauréat* [A-levels] often extend their investments until their children have this degree but only until this, even though this degree no longer meets the negative and positive functions it formerly filled [...]".

[3] [1], p.13.

[4]"All of these studies find correlations approximately twice as high as those of the earlier studies, in part as a result of the errors in variables and life-cycle problems affecting the earlier studies. Their findings call into question Becker's conclusion in 1988 that 'low earnings as well as high earnings are not strongly transmitted from fathers to sons' " ([7], p.1843).

[5]Note that debt aversion to debt depends on both risk aversion and on expected returns to educational investments. Note also that, in an way, our model catches indirectly the difficulties that the most disadvantaged population is facing because of its specific borrowing constraints.

In the next section, we analyse the impact of this change of assumption on the results outlined by [6].

2 The model

2.1 The population

2.1.1 Workers categories and utilities

Before introducing heterogeneity, we recall [6]'s assumptions and notations. The modifications we propose are presented in Section 2.1.2.

Workers are divided in two categories: skilled who are graduated, and unskilled, who did not study. Unskilled workers' wage is a constant rate w_0. Students pay tuition charges p during the first period (and do not receive wages). They become skilled workers after completing their studies.

Skilled workers' wage depends on a common skilled premium $K(q)$ (earned by means of education), where q is the number of graduates[6]. It also depends on individual's talent (or "ability"), modelled by a random variable $\tilde{\theta}$. Taking into account a constant preference for present r, we can write individual infinite horizon inter-temporal utilities as follows:

- for an unskilled worker: $u_0 = w_0 + \frac{\ln(w_0)}{r}$

- for a skilled worker: $u_1 = -p + \frac{\ln(w_0) + \tilde{\theta} + K(q)}{r}$

Let $\theta = \frac{\tilde{\theta}}{r}$ and $\Delta(q) = \frac{K(q)}{r}$. The difference between utilities is then:

$$u_1 - u_0 = \Delta(q) + \theta - p - w_0$$

where θ is supposed to be Gaussian with zero mean and variance σ_θ^2. Information on θ is supposed incomplete and asymmetric. A potential student with ability θ observes a noisy signal s that will be modelled in the following section, whereas the university observes the tests results that provide another estimation of the ability:

$$z = \theta + \nu, \text{ with } \nu \sim \mathcal{N}(0, \sigma_\nu).$$

The university sets an admission standard z_0. If $z < z_0$, the individual is not allowed to apply. Otherwise, potential students choose to register or not, and dispose of two information sources to estimate their θ: their private signal s and the fact that $z \geq z_0$. In this situation, we face bilateral asymmetric information since both the university and the potential student have only indirect access to the private signal of the other part. The case of one-sided asymmetric information is considered in Section 2.3.

Potential students apply for higher education if their expected utility as skilled worker (u_1) is higher than the utility of unskilled workers (u_0):

$$\mathbb{E}[u_1|s, z \geq z_0] = \mathbb{E}[\theta|s, z \geq z_0] - p + \frac{\ln(w_0)}{r} + \Delta(q) \geq u_0$$

$$\Leftrightarrow \mathbb{E}[\theta|s, z \geq z_0] \geq p + w_0 - \Delta(q)$$

Let $\hat{\theta} = \mathbb{E}[\theta|s, z \geq z_0]$: for a potential student, it is the expectation of her own ability.

Let $\theta_0 = p + w_0 - \Delta(q)$: it is the minimum expected ability below which applying for higher education is not worthwhile.

---

[6]As underlined by [6], the function K can by either increasing or decreasing: skilled workers can be seen in concurrence on the labour market and therefore their amount would have a negative impact on their wage; but a large amount of skilled workers could also increase high-wage job opportunities by developing a knowledge economy.

2.1.2 Heterogeneous population

In this section, we model the private signal s of a potential student on her ability θ assume to be purely random: $\theta \sim \mathcal{N}(0, \sigma_\theta)$. To introduce heterogeneity in the population, the signal is supposed social group-dependent.

In group A, with population N_A, of individuals coming from "privileged" classes, the signal is the same as in [6]'s model:

$$s_A = \theta + \varepsilon, \text{ with } \varepsilon \sim \mathcal{N}(0, \sigma_\varepsilon).$$

In group B, with population N_B, of individuals coming from "disadvantaged" classes, a negative bias impacts the signal:

$$s_B = \theta - \delta + \varepsilon, \text{ with } \varepsilon \sim \mathcal{N}(0, \sigma_\varepsilon) \text{ and } \delta > 0.$$

Let $\hat{\theta}_A$ and $\hat{\theta}_B$ be the value of $\hat{\theta}$ for an individual from groups A and B, respectively. The opportunity of higher education depends on the group and is given by:

$$\hat{\theta}_A = \mathbb{E}[\theta|s_A, z \geq z_0] \quad \geq \theta_0$$
$$\hat{\theta}_B = \mathbb{E}[\theta|s_B, z \geq z_0] \quad \geq \theta_0$$

Let us underline that the bias of group B impacts the estimation of θ. As this bias is not conscious, the estimator of θ for group B is the same as for group A. It is therefore based on the one hand on the misspecified model $s = \theta + \varepsilon$ and on the other hand on the correct model $z = \theta + \nu$. The estimator $\hat{\theta}$ can be decomposed as a function of s and $\mathbb{1}_{z \geq z_0}$, for any potential student, whatever the group, as follows:

$$\hat{\theta} = us + v\mathbb{1}_{z \geq z_0}$$

Consider two potential students with same abilities θ and same noise ε but from different groups. The individual from group B estimates less beneficial to apply for higher education since:

$$\hat{\theta}_A - \hat{\theta}_B = us_A + v\mathbb{1}_{z \geq z_0} - us_B - v\mathbb{1}_{z \geq z_0}$$
$$= u\delta > 0$$

2.2 Optimal tuition fees

In this section, we study the case of a "philanthropic" university and investigate how tuition fees should be set in order to maximise social surplus.

2.2.1 Bilateral asymmetric information

Here we suppose that university signal is non public and that potential students are only informed of their success to the test.

We set $P_A(\theta_0, z_0) = \mathbb{P}\left(\hat{\theta}_A \geq \theta_0, z \geq z_0\right)$ the probability that a potential student from group A applies for higher education and by $v_A(\theta_0, z_0) = \mathbb{E}[\theta|\hat{\theta}_A \geq \theta_0, z \geq z_0]$ the conditional expectation of θ for the resulting skilled worker. The corresponding v_B and P_B for group B are defined in a similar way.

A "philanthropic" university would maximise the expected social surplus given by the sum of individual expected utilities on the population ($q = N_A P_A(\theta_0, z_0) + N_B P_B(\theta_0, z_0)$ skilled and $N - q$ unskilled workers) minus the cost of higher education:

$$W = q[\Delta(q) - w_0] + N_A P_A(\theta_0, z_0) v_A(\theta_0, z_0) + N_B P_B(\theta_0, z_0) v_B(\theta_0, z_0) - C(q) + Nu_0$$

This social surplus is maximised with respect to the expected amount of students q, the admission standard z_0 and the tuition fees p (or equivalently θ_0) and under the constraint that $q = N_A P_A(\theta_0, z_0) + N_B P_B(\theta_0, z_0)$.

Let us start by maximising W with respect to z_0 and θ_0 for a fixed value of q. The Lagrangian corresponding to this maximisation is given by:

$$L = q[\Delta(q) - w_0] + q v_A(\theta_0, z_0) + N_B P_B(\theta_0, z_0)(v_B(\theta_0, z_0) - v_A(\theta_0, z_0))$$
$$- C(q) + N u_0 + \lambda[q - (N_A P_A(\theta_0, z_0) + N_B P_B(\theta_0, z_0))]$$

This yields to the following optimal tuition fees [see 2, for a detailed calculation]:

$$p = C'(q) - q\Delta'(q) - \frac{u\delta N_B \frac{\partial P_B}{\partial \theta_0}}{N_A \frac{\partial P_A}{\partial \theta_0} + N_B \frac{\partial P_B}{\partial \theta_0}}$$

In absence of heterogeneity, the optimal tuition fees are $p = C'(q) - q\Delta'(q)$ [see 6]. They are therefore reduced by a quantity (the fraction) that comes from the need to counterbalance the bias of potential students from group B. This leads to the following proposition:

Proposition 1. *In a "philanthropic" view, in presence of heterogeneity in the population leading to underestimation of the ability for some individuals, optimal tuition fees p_{het}^* are lower than for an homogeneous population (p_{hom}^*), given the amount of student:*

$$p_{het}^* = p_{hom}^* - \frac{u\delta}{1 + \frac{N_A}{N_B} \frac{\partial P_A \partial \theta_0}{\partial P_B / \partial \theta_0}}.$$

Remark 1. The effect of heterogeneity increases with the relative weight of group B in the population. As expected, this effect vanishes when group B becomes negligible.

Remark 2. The effect of heterogeneity increases with u: i.e. when potential students, deciding whether applying or not for higher education, use more their personal signal (s) than the information given by their success at the university examinations ($z \geq z_0$). Therefore, the information given by the test is the only way to counterbalance the psychological bias of group B. The bias is sort of "balanced" by the success at the test [7].

2.3 One-sided asymmetric information

We suppose here that university's signal z is public.

In such a case, since z is known, potential students can use more information than previously to estimate if higher education is beneficial. Since social utility and individual utility are supposed to vary in the exactly same way through the evolution of wage, individual choices are also socially optimal.

The resulting proposition is similar to the one of section 2.2.1.

Proposition 2. *In the case of a "philanthropic" university and if z is public, tuition fees should be set lower for a heterogeneous population than for an homogeneous population, for a fixed amount of students:*

$$p_{het}^* = p_{hom}^* - \frac{\alpha\delta}{1 + \frac{N_A}{N_B} \frac{\partial P_A \partial \theta_0}{\partial P_B / \partial \theta_0}}.$$

---

[7]Nevertheless, the problem may only be postponed: for the same reasons that led to introduce δ, numerous papers (notably in sociology) reveal the presence of a bias, adverse to students from "disadvantaged" groups. This bias is said to be due to "social codes" needed to pass examinations (and $z \geq z_0$ would therefore be biased as well). This would advocate for a large test, eventually compulsory, as the French "baccalauréat". Further research should investigate this issue.

where α measures [8] *the information on θ coming from the personal signal s.*

Since z is directly available to potential students, and not any more indirectly through $\mathbb{1}_{z \geq z_0}$, the effect discussed in the previous section is reinforced: as information coming from z increases (i.e. as σ_v decreases with respect to σ_ε), potential students from group B become aware of their talent. In the limit case where the test brings complete information on the talent, the effect of the psychological bias vanishes ($\alpha = 0$). Optimal tuition fees are then equivalent to the case of an homogeneous population.

3 Discussion and perspectives

The literature highlights distorted behaviours of students, depending on the social class they belong to: individuals from lower social groups tend to under-estimate their ability and the expected returns of educational investment. Based on this observation, we proposed in this article to take into account this heterogeneity of the population to build a model for applicants behaviour.

Following our hypothesis, it appears that tuition fees are inefficient as a tool of selection for at least two reasons: (i) they tend to move away the good students that should have entered university for both individual and social benefit but that have underestimated their talents; (ii) they also tend to include low talented students coming from privileged families.

Relying on this bias, highlighted by a rich literature, we have shown that tuition fees should be set below the level that would be fixed for a homogeneous population and the same volume of students. This conclusion is particularly important since empirical studies have deduced that most of the population does not really face borrowing constraints when making a decision for further studies. This decision depends on other criteria, primarily social ones, that are strong enough disincentives for university enrolment and for running into debt. They can distort the corresponding educational choices and job opportunities. Low enough tuition fees appear then as a key and necessary (even though not sufficient) condition in order to achieve a socially optimal equilibrium.

However, further research has to be done in order to guarantee that assumptions are strong enough to implement recommendations coming from such a model. Our work should also be extended in order to determine concretely the level of these "optimal" tuition fees : Are they higher than those applied today? Lower? Even negative? Are they still relevant to select potential students applying at university? Those dimensions depend in particular on the parameters including the population distribution among the two social groups as well as on the characteristics of these populations.

Another perspective concerns the likely endogenous nature of individuals' abilities, modelled by θ: If individuals' talents are not only "revealed" through education but also developed by it, in a dynamic perspective, the fees should be even lower in order to keep in the system a population initially low "gifted" but improving their potential by studying.

However, staying with exogenously distributed and static abilities, the social welfare would appear particularly important since the educational system integrates stronger incentives for "very good but very poor" students and disincentives for "low talented but very rich" students.

---

[8]The coefficient α is given by the estimation of θ from s and z (instead of s and $\mathbb{1}_{z \geq z_0}$):

$$\bar{\theta} = \mathbb{E}[\theta|s,z] = \alpha s + \beta z.$$

with

$$\alpha = \sigma_\theta^2 \frac{V(z) - Cov(s,z)}{V(s)V(z) - Cov^2(s,z)} = \frac{\sigma_v^2}{\sigma_v^2 \sigma_\theta^2 + \sigma_\theta^2 \sigma_\varepsilon^2 + \sigma_v^2 \sigma_\varepsilon^2}.$$

Note nevertheless that a social rank bias can appear on the test itself (either on the inscription to the test or on the possession of the "social codes" needed to succeed the test). In such a case, even a ideal test revealing perfectly the talent of individuals of group A would not be sufficient to select efficiently.

Such a remark suggests to develop further research on the selection relying on entry examinations. It also suggests research perspectives concerning possibly more efficient (not homogeneous) pricing mechanisms. These mechanisms can be considered directly (by adjusting fees according to various criteria) or indirectly (through grants). Some institutions are already testing this approach, fees being based on social criteria (parental income) or "merit" ones since attracting the best students creates positive externalities for universities (reputation effect) and students (peer effect). The level of tuition fees could also be designed according to the job and to the real income of the student after graduation.

Finally, tuition fees can be seen not only as a selection tool and further work could be done exploring the other (also questionable) justifications of fees provided by the literature. These are of three types: *Incentive*, *contributory* and *redistributive* ones.

(i) Incentive justifications. A first incentive has been reviewed in this article: It consists in using tuition fees to exclude the worst students from higher education and to encourage the best ones to get enrolled. Another incentive is linked to the motivation of students and teachers. Indeed, it would become very expensive for students not to study (or to study little) while paying high fees. At the same time, teachers would be involved because of students' motivation and demands, and possibly by a system of bonuses (partly funded by the fees). *(ii) Contributory justifications.* By paying fees, students contribute to finance universities and thus to increase the quality of their education (by recruiting the best teachers, by funding research, by improving working conditions). *(iii) Redistributive justifications.* The fees could play a redistributive role since universities are mostly frequented by the upper social classes.

Each of these dimensions require a specific discussion and further research in order to consider whether (or not), in other forms or for other reasons, the introduction of "significant" tuition fees might remain relevant. However, as far as shown in this article, tuition fees as a "good" tool of selection have to be put into perspective. Further work has to be done before providing definitive conclusions. It has also to be done before implementing "high tuition fees policies", since this implementation will undoubtedly lead to an in-depth transformation of their economic, social and cultural patterns of development.

References

[1] Pierre Bourdieu. Avenir de classe et causalité du probable. *Revue française de sociologie*, 15:3–42, 1974.

[2] David Falcher and Hugo Harari-kermadec. Efficient tuition fees and examinations : A reply. hal-00443971, 2010.

[3] Ross Finnie, Eric Lascelles, and Aarthur Sweetman. Who goes? the direct and indirect effects of family background on access to post-secondary education. Technical Report 237, Statistics Canada, Ottawa, January 2005.

[4] Robert J. Gary-Bobo and Alain Trannoy. Efficient tuition & fees, examinations and subsidies. *CEPR Discussion paper*, 5011, 2005.

[5] Robert J. Gary-Bobo and Alain Trannoy. Faut-il augmenter les droits d'inscription à l'université ? *Revue française d'économie*, 19(3):189–237, 2005.

[6] Robert J. Gary-Bobo and Alain Trannoy. Efficient Tuition Fees and Examinations. *Journal of the European Economic Association*, 6(6):1211–1243, 2008.

[7] Robert Haveman and Barbara Wolfe. The determinants of children's attainments: A review of methods and findings. *Journal of Economic Literature*, 33(4):1829–1878, 1995.